



The Eyjabakkajökull Glacier is an outlet glacier of the Vatnajökull ice cap in Iceland. It has been retreating since a major surge occurred in 1973. This true-color Landsat-7 image shows the glacier terminus in September 2000. The light- and dark-blue outlines show the terminus extent in 1973 and 1991, respectively.

Problem 1 - Using a metric ruler, and the conversion 1 mile = 1.61 kilometers, what is the scale of the image in meters per millimeter?

Problem 2 - How many kilometers did the glacier retreat between A) 1973 and 1991? B) 1991 and 2000?

Problem 3 - From your answers to Problem 2, what is the average rate of retreat in kilometers per year between A) 1973-1991, and B) 1991 to 2000? C) Is the retreat of the glacier speeding up or slowing down?

Problem 4 - Assume that the height of the glacier is 1000 meters. About what volume of ice has been lost between 1973 and 1991 in cubic kilometers, assuming that the missing ice is shaped like a wall?

Answer Key

Problem 1 - Using a metric ruler, and the conversion 1 kilometer = 0.62 miles, what is the scale of the image in meters per millimeter? **Answer; The 1-mile legend on the lower right measures 14mm wide, and since 1 mile = 1.61 km, the scale is $1610 \text{ meters}/14\text{mm} = 115 \text{ meters}/\text{mm}$.**

Problem 2 - How many kilometers did the glacier retreat between
 A) 1973 and 1991? **Answer; At the head of the glacier (top end) the distance is 8 mm or $8 \times 115 = 920 \text{ meters}$.**
 B) 1991 and 2000? **Answer: the distance traveled is about 10mm or $10 \times 115\text{m} = 1,150 \text{ meters}$.**

Problem 3 - From your answers to Problem 2 ,what is the average rate of retreat in kilometers per year between A) 1973-1991: **$920 \text{ meters}/18 \text{ years} = 51 \text{ meters}/\text{year}$.** and B) 1991 to 2000? **$1150 \text{ meters}/9 \text{ years} = 128 \text{ meters}/\text{year}$.**
 C) Is the retreat accelerating (speeding up or slowing down?) **Answer: the retreat is definitely speeding up ($51 \text{ m}/\text{yr}$ compared to $128 \text{ m}/\text{yr}$).**

Problem 4 - Assume that the height of the glacier is 1000 meters. About what volume of ice has been lost between 1973 and 1991 in cubic kilometers?

Answer: The height of the wall is 1000 meters. The width of the wall is estimated by using the average width of the retreated ice between 1973 and 2000, which from the photo is about $(5\text{mm} + 8\text{mm} + 20 \text{ mm})/3 = 11 \text{ mm}$ or $11 \times 115 \text{ m}/\text{mm} = 1,300 \text{ meters}$. The length of the wall is the perimeter of the retreating ice which is about $140 \text{ mm} \times 115 \text{ m}/\text{mm} = 16,000 \text{ meters}$. The volume in cubic kilometers is then $1.0\text{km} \times 1.3\text{km} \times 16 \text{ km} = 21 \text{ cubic kilometers}$!